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[54] COOKING APPLIANCE HAVING A COOLING MECHANISM AND METHOD OF OPERATION

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[52] U.S. Cl. .... 219/716; 219/719; 219/757; 219/492; 126/21 A

[58] Field of Search .... 219/10.55 G, 10.55 R, 219/10.55 M, 400, 492, 715, 716, 719, 722, 723, 757; 126/21 A; 361/384

[56] References Cited

U.S. PATENT DOCUMENTS

3,808,391	4/1974	Graff et al.	219/10.55 C
3,867,605	2/1975	Yee	219/10.55 B
4,547,642	10/1985	Smith	219/10.55 B
4,628,439	12/1986	Fowler et al.	219/10.55 B
5,098,665	3/1992	Katschnig et al.	219/10.55 D

FOREIGN PATENT DOCUMENTS

63-223422 9/1988 Japan .

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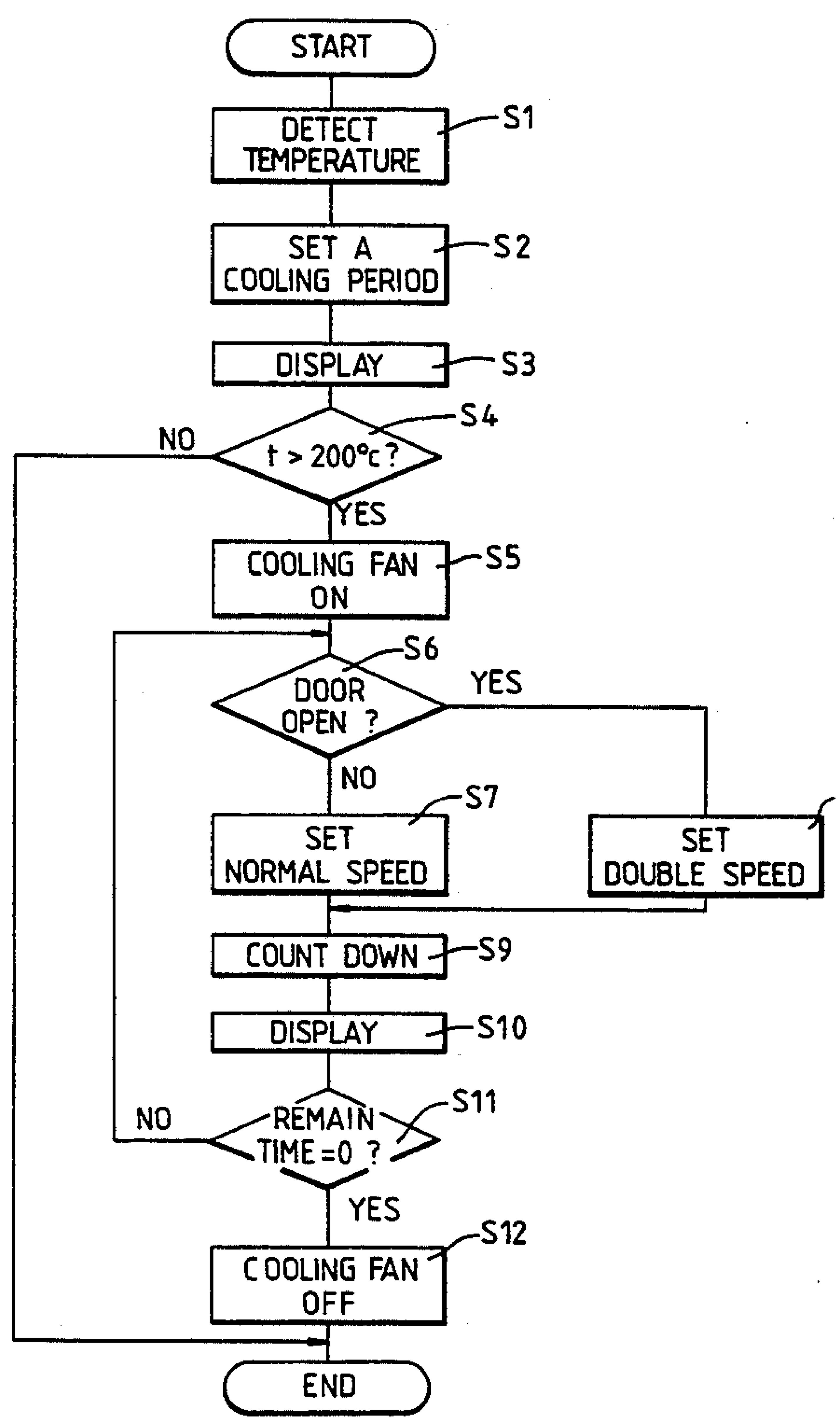
[57] ABSTRACT

A cooking appliance has a cooking compartment accessed by a door. After cooking is finished, a sensor detects the temperature within the cooking compartment. Then a cooling fan cools components in the cooking appliance for a period of time dependent on the detected temperature. A control circuit changes the period for cooling in accordance with the time that the door is open while the fan is on.

9 Claims, 3 Drawing Sheets



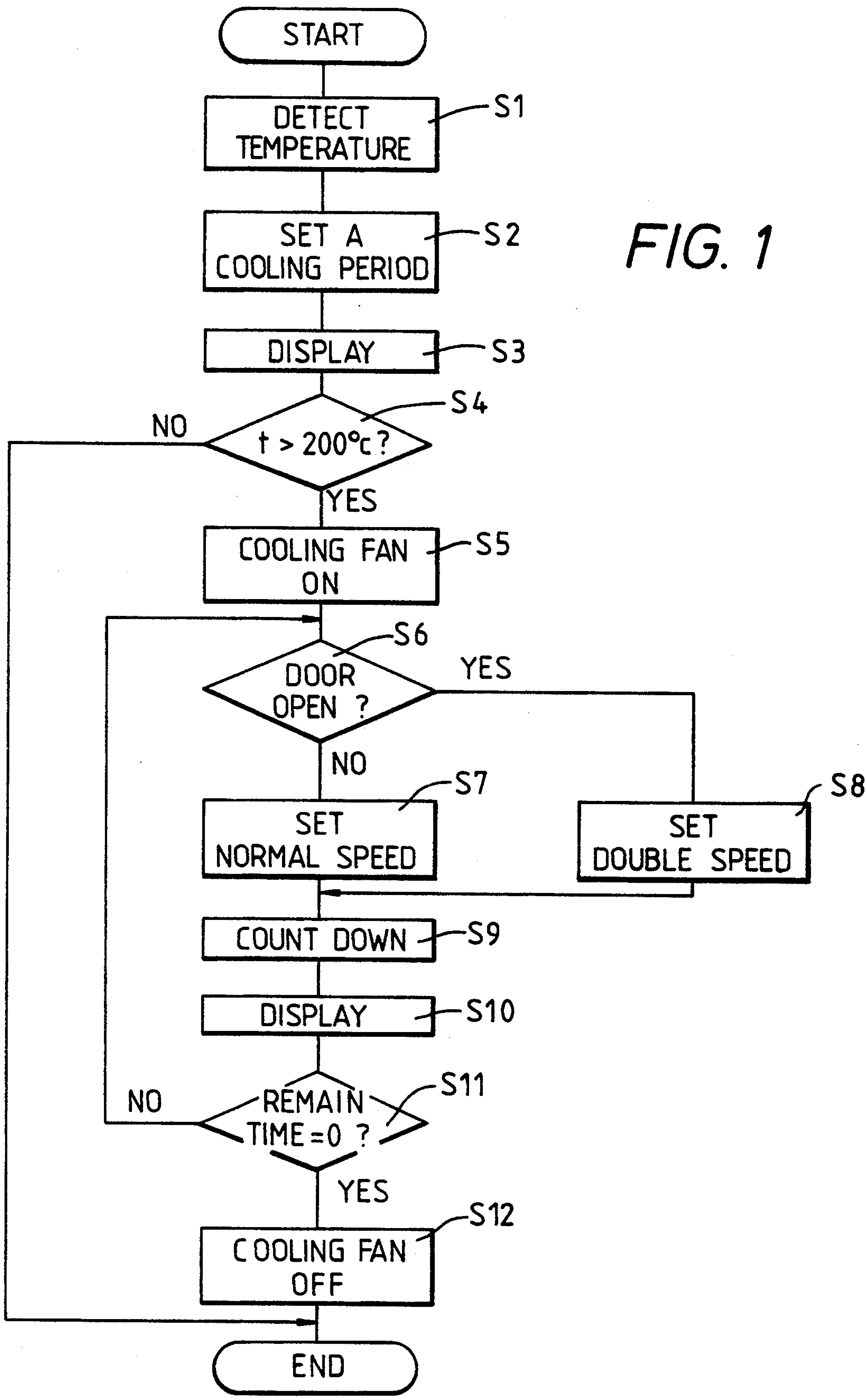

START
DETECT TEMPERATURE
S1
SET A COOLING PERIOD
S2
DISPLAY
S3
t > 200°c ?
S4
NO
YES
COOLING FAN ON
S5
DOOR OPEN ?
S6
YES
NO
SET NORMAL SPEED
S7
SET DOUBLE SPEED
S8
COUNT DOWN
S9
DISPLAY
S10
REMAIN TIME=0 ?
S11
NO
YES
COOLING FAN OFF
S12
END

FIG. 1

FIG. 2

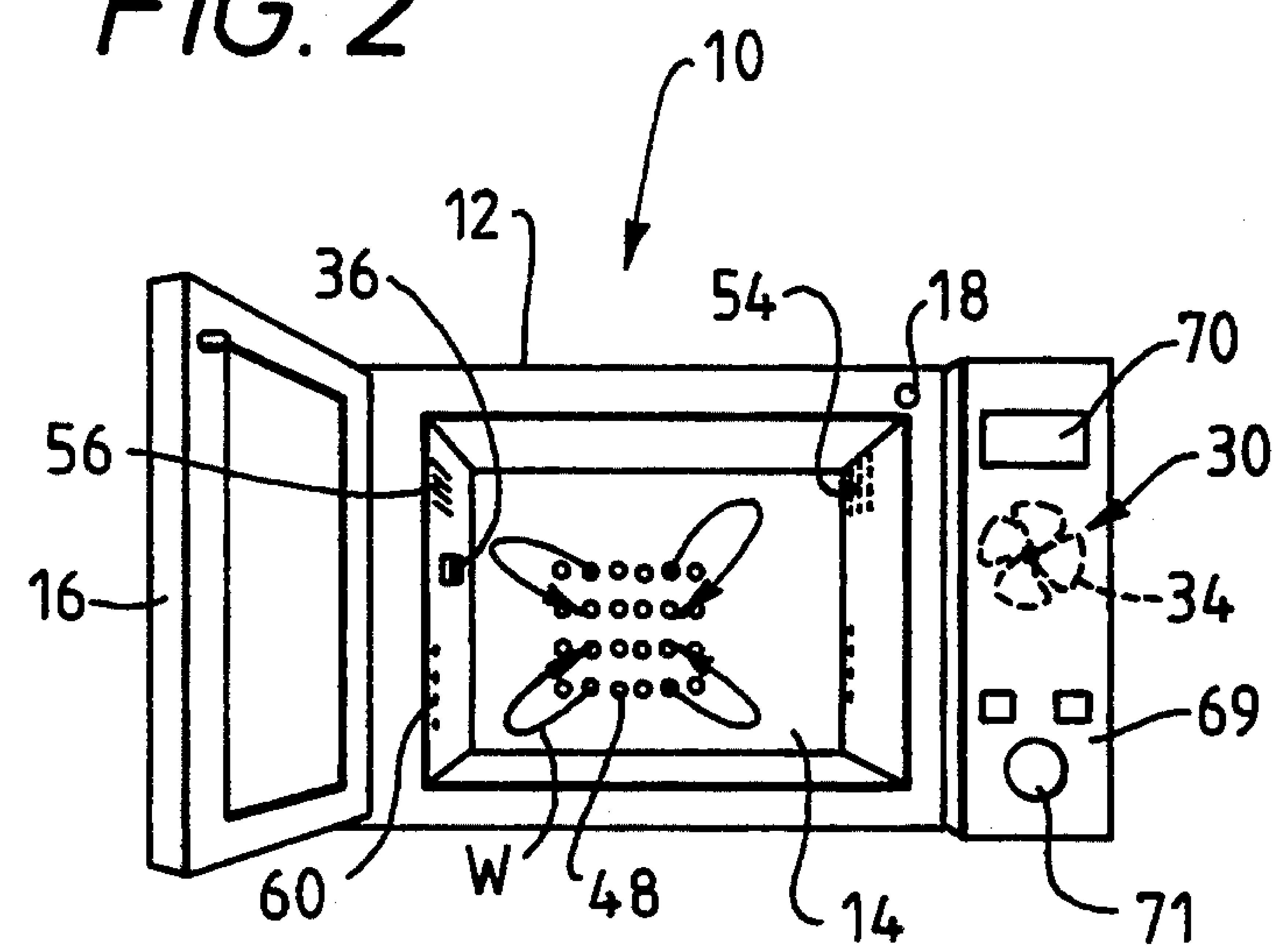

10
12
36
54
18
70
56
30
16
34
69
60
W
48
14
71

FIG. 3

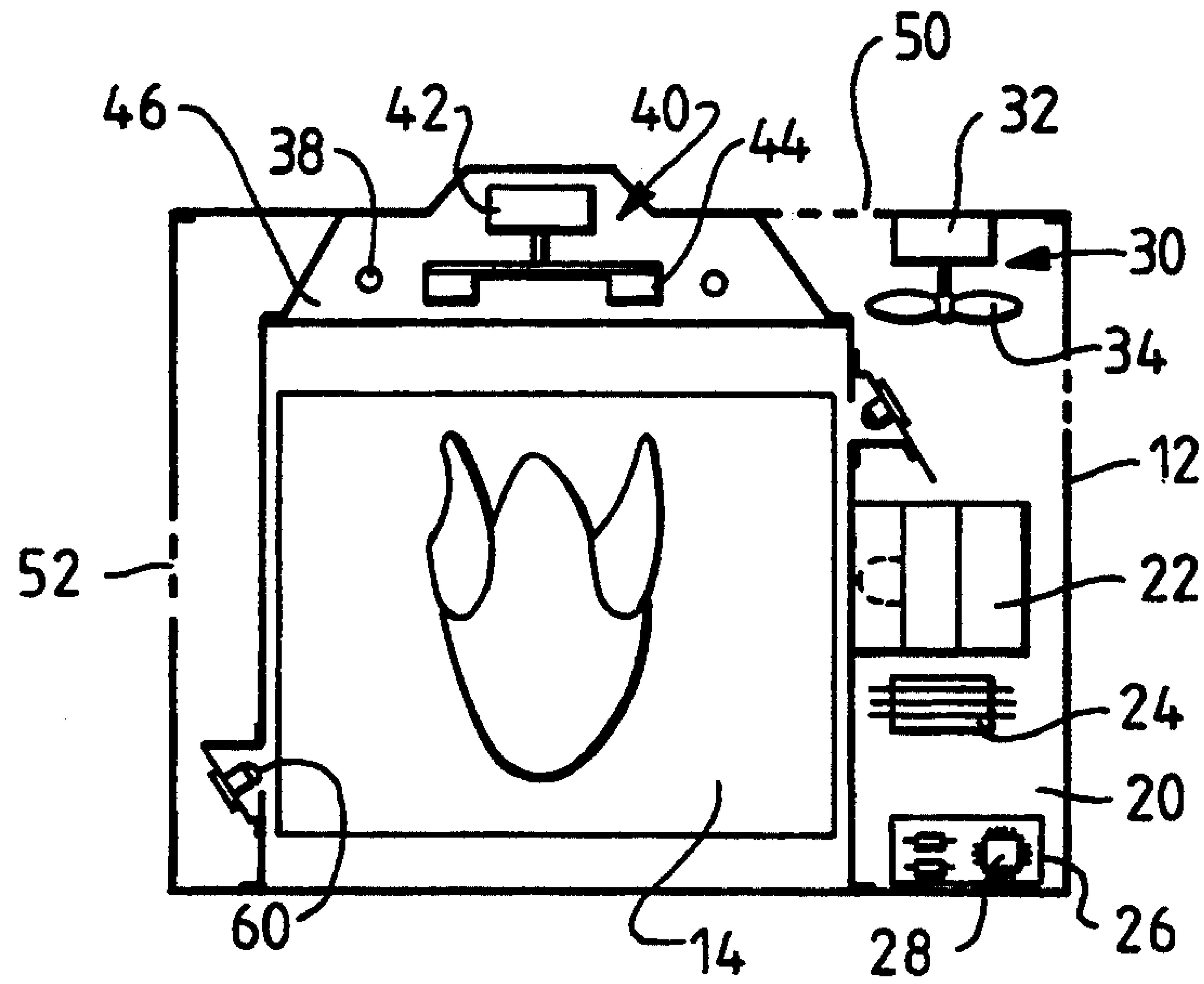

50
46
42
40
44
32
38
30
34
12
52
22
24
20
60
14
28
26

FIG. 4

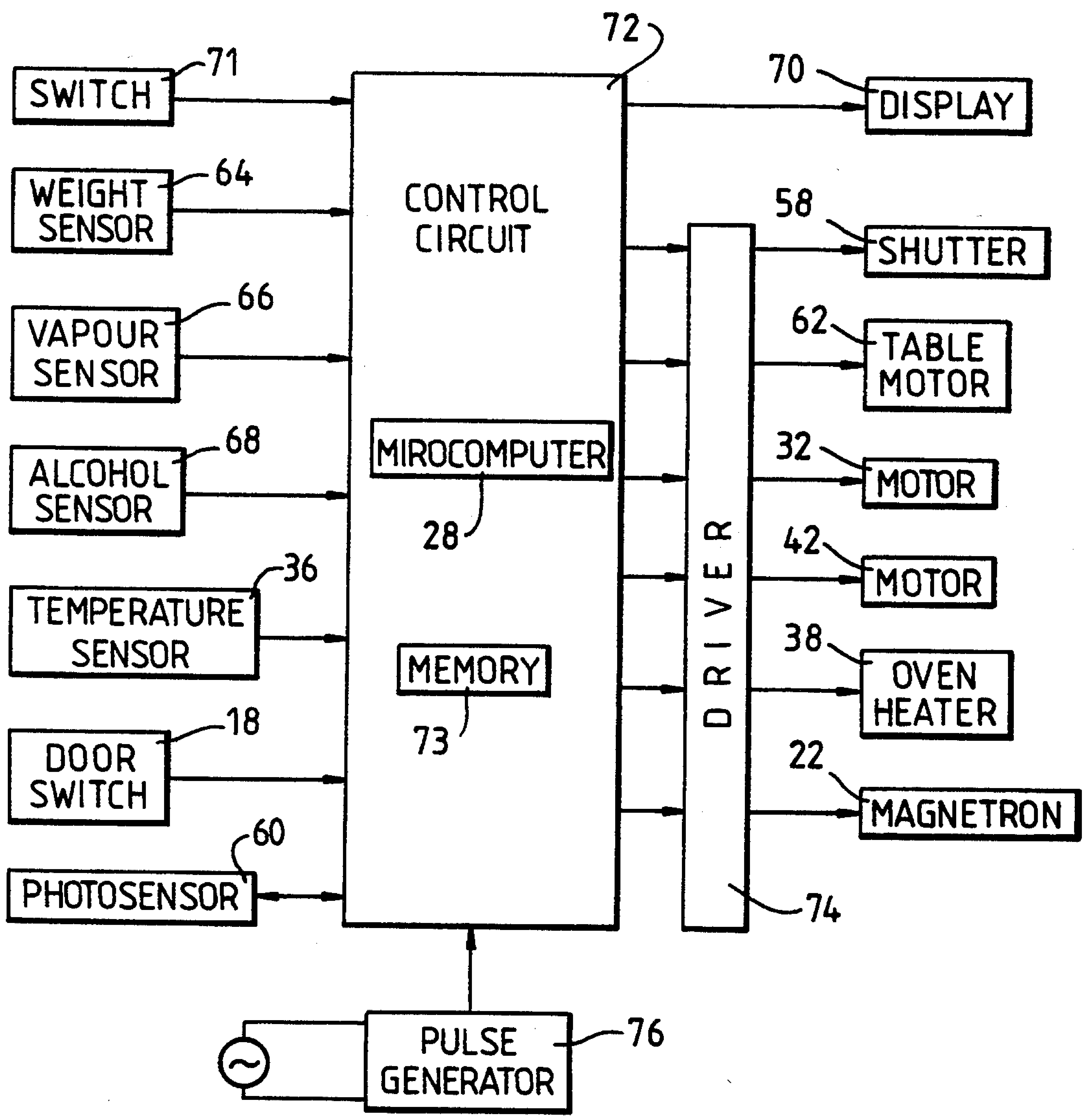
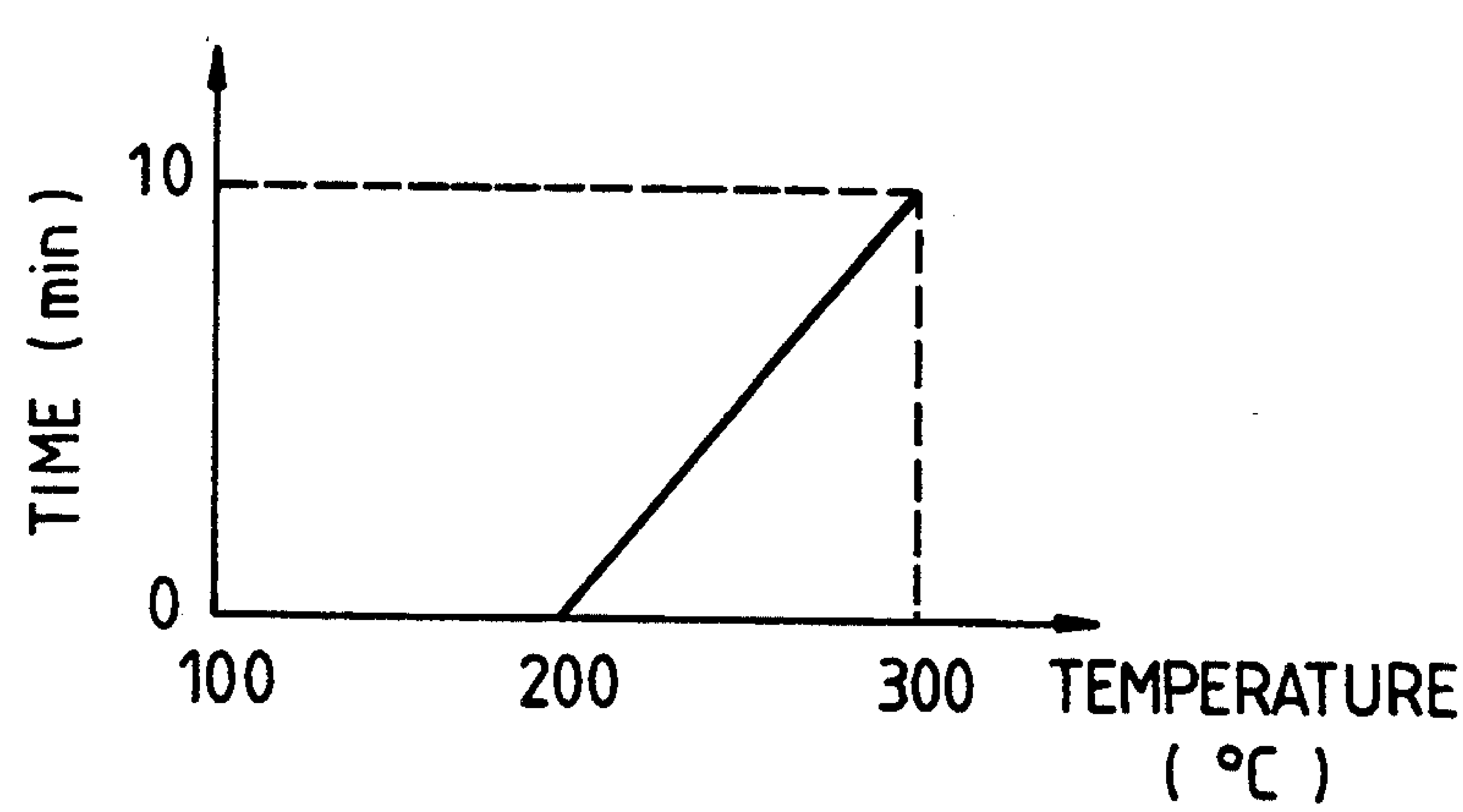

SWITCH
71
WEIGHT SENSOR
64
VAPOUR SENSOR
66
ALCOHOL SENSOR
68
TEMPERATURE SENSOR
36
DOOR SWITCH
18
PHOTOSENSOR
60
72
CONTROL CIRCUIT
MIROCOMPUTER
28
MEMORY
73
DRIVER
74
PULSE GENERATOR
76
70
DISPLAY
58
SHUTTER
62
TABLE MOTOR
32
MOTOR
42
MOTOR
38
OVEN HEATER
22
MAGNETRON

FIG. 5


TIME (min)
10
0
100
200
300
TEMPERATURE (°C)

COOKING APPLIANCE HAVING A COOLING MECHANISM AND METHOD OF OPERATION

BACKGROUND OF THE INVENTION

The present invention relates to a cooking appliance having a cooking compartment.

A prior cooking appliance, for example, a microwave oven having a cooking compartment and oven cooking function, has a cooling fan. When a user uses the oven cooking function, the temperature within the cooking compartment and around components positioned in an outer case of the oven rises. After oven cooking is finished, the cooling fan cools the components so that their temperature does not exceed their tolerance level.

The cooling time is determined in any of three ways. First, a temperature sensor is positioned adjacent a component which has the lowest temperature tolerance. Until the sensor detects that the temperature is under the tolerance level, the cooling fan continues to cool the components.

Second, a temperature sensor is positioned in the cooking compartment so that the sensor detects the temperature within the cooking compartment. Until the sensor detects that the temperature is less than a predetermined temperature, the cooling fan continues to cool the components. The predetermined temperature is set to a presumptive value at which the temperature of all components is presumed to be under the tolerance level.

Third, a cooling time is determined in accordance with the temperature set by a user for oven cooking. The cooling fan cools the components for the determined cooling time.

However, the first approach requires the sensor to be attached to the component, increasing manufacturing costs.

With the second approach, if a door to the cooking compartment is opened while the cooling fan is actuated, the temperature within the cooking compartment drops rapidly. As a result, since the temperature drops under the predetermined temperature, the cooling fan stops cooling the 10 components. Although the temperature drops under the predetermined temperature, the temperature of the components often does not drop enough. As a result, the cooling time is too short.

With the third approach, if the door is open while the cooling fan is running, the compartment is efficiently cooled by the outside air. As a result, although less cooling time is required, the cooling fan continues to run. Therefore, the cooling fan operates unnecessarily for a certain time.

SUMMARY OF THE INVENTION

It is an object to provide a cooking appliance and method of operation which can cool components for a proper period, while minimizing manufacture costs.

In order to achieve the above object in the present invention, the period of time that a door of a cooking compartment of a cooking appliance is open during cooling is monitored. The period of time that a cooling fan is operated during cooling is changed in accordance with the time the door is open.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of this invention will become apparent and more readily appreciated from the following description of the presently preferred exemplary embodiments, taken in conjunction with the accompanying drawings, of which:

FIG. 1 is a flow chart illustrating operation of a cooking appliance according to the present invention;

FIG. 2 is a front view of the cooking appliance;

FIG. 3 is a cross section of the cooking appliance;

FIG. 4 is a block diagram of the circuitry of the cooking appliance; and

FIG. 5 shows a graph showing a connection between the temperature of a cooking compartment and a cooling time.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EXEMPLARY EMBODIMENTS

Embodiments in which the present invention are employed in a microwave oven with an oven cooking function will be described with reference to the drawings.

With reference to FIG. 2, a microwave oven **10** has an outer case **12**. A cooking compartment **14** for receiving food is located in outer case **12**. A door **16** is pivotally provided in front of cooking compartment **14**.

A door switch **18**, which detects whether door **16** is open, is located on a front edge of cooking compartment **14**. When door **14** is closed, door switch **18** contacts with the door.

With reference to FIG. 3, a components compartment **20** is provided between outer case **12** and cooking compartment **14**. A magnetron **22**, which generates microwaves to be supplied to cooking compartment **14**, a transformer **24** and a printed circuit board **26** on which a microcomputer **28** is provided, are located in components compartment. A cooling fan **30** including a motor **32** and a fan **34** is provided near magnetron **22** in components compartment **20**.

A temperature sensor **36** which detects the temperature within cooking compartment **14** is located on a side wall of the cooking compartment. An oven heater **38** and a circulation device **40**, including a motor **42** and a fan **44**, are located behind in a rear portion **46** cooking compartment **14**.

During oven cooking, oven heater **38** heats air within rear portion **46**. Circulation device **40** causes the heated air to circulate in cooking compartment **14** through holes **48** as shown by arrows W in FIG. 2 so that the temperature within cooking compartment **14** increases gradually.

An air intake hole **50** and an exhaust hole **52** are provided on outer case **12**. An air inlet **54** and an air outlet **56** are provided on cooking compartment **14**. A shutter **58** (as shown in FIG. 4) is located on air inlet **54**, which can shut the air inlet based on a command from microcomputer **28**.

When motor **32** rotates fan **34**, outside air is drawn into components compartment **20** through intake hole **50**. After the air cools magnetron **22** and other components, the air flows into cooking compartment **14** through air inlet **54** because shutter **58** is open. The air within cooking compartment **14** is exhausted through air outlet **56** and exhaust hole **52**.

Four pairs of photosensors **60**, which detect the shape or height of food, are positioned on the side wall of cooking compartment **14**. Photosensors **60** are also cooled by the air from fan **34**.

During microwave cooking, a rotatable and detachable plate (not shown) is positioned on a bottom portion within cooking compartment **14**. The plate is rotated by a table motor **62** (see FIG. **4**). A weight sensor **64** provided under cooking compartment **14** weighs food placed on the plate.

A vapor sensor **66**, which detects vapor generated by cooking food, is positioned between air outlet **56** and exhaust hole **52**. An alcohol sensor **68**, which detects alcohol generated by the food is positioned near vapor sensor **66**.

An operation panel **69** is positioned on a front surface of outer case **12**. A display **70** which indicates cooking mode and time is located on operation panel **69**. Plural kinds of switch **71** such as a start switch is located on operation panel **69**.

With reference to FIG. **4**, a control circuit **72** including microcomputer **28** has a memory **73**. Microwave oven **10** is controlled based on a program stored in memory **73**. Switch **71**, weight sensor **64**, vapor sensor **66**, alcohol sensor **68**, temperature sensor **36**, door switch **18** and a pulse generator **76** are connected and send signals to control circuit **72**. Control circuit **72** sends commands to photosensors **60** and receives signals detected by them. Control circuit **72** directly controls display **70**, and controls magnetron **22**, oven heater **38**, motors **42**, **43** and **62** and shutter **58** through a driver **74**.

For oven cooking, a user makes the appropriate selections using switches **71** and sets both a desired temperature within cooking compartment **14** and a cooking time. When the user presses a start switch, oven heater **38** heats air within rear portion **46** and fan **44** circulates the heated air through holes **48**. Until a temperature within cooking compartment **14** reaches the predetermined value as set by the user, oven heater **38** and motor **42** are energized continuously. After that, heater **38** and motor **42** are energized intermittently so that the temperature **10** is maintained at the set temperature.

After oven cooking is finished or cancelled during cooking, cooling fan **30** cools the components such as magnetron **22**, photosensors **60**, and print circuit board **26**. FIG. **1** is a flow chart illustrating the operation of cooling fan **30** after cooking is finished. The operation is based on the program stored in memory **73**. When oven cooking is finished, temperature sensor detects a temperature within cooking compartment **14** (step **S1**). Control circuit **72** determines a cooling period based on the temperature (step **S2**). Display **70** displays the cooling period (step **S3**).

In this case, control circuit **72** determines the cooling period based on FIG. **5**, which illustrates the relation between the temperature in cooking cabinet **14** and a cooling time. Data in accordance with FIG. **5** are stored in memory **73** as a time table.

As a specific example, a cooling period is set for ten minutes when the temperature in the oven is 300° C. and the cooling period is set for 0 minutes when the temperature is 200° C. A relation between the temperature and a cooling period is linear when the temperature is in a range between 200° C. and 300° C. When the temperature is under 200° C., the cooling fan **30** does not operate.

Control circuit **72** determines whether the temperature exceeds 200° C. (step **S4**). If not, processing is finished. If so, the cooling fan **30** begins to cool the components (step **S5**). Control circuit **72** determines whether door **16** is open based on a signal from door switch **18** (step **S6**). If door **16** is closed, control circuit **72** causes the cooling period to be counted at a normal speed (step **S7**). In detail, when control circuit **72** receives **50** pulses from pulse generator **76**, the control circuit causes the remaining cooling period to be decreased by one second.

If door **16** is open, control circuit **72** sets a counting speed of the cooling period as twice the normal speed (step **S8**). In detail, when control circuit **72** receives **25** pulses from pulse generator **76**, the control circuit causes the remaining cooling period to be decreased by one second.

Therefore, when the normal speed is set, one second on display **70** indicates one second of actual time. When the double speed is set, one second on display **70** indicates 0.5 seconds of actual time.

Control circuit **72** begins to count down the remaining cooling period (step **S9**). Display **70** displays the remaining time in the cooling period (step **S10**). Then, control circuit **72** determines whether the cooling period has expired (step **S11**). If not, flow returns to step **S6**. If so, cooling fan **30** stops rotating and the display of cooling time on display **70** is discontinued (step **S12**).

According to the embodiment, the cooling period is set based on the temperature within cooking compartment **14** when cooking has finished. If door **16** is open while cooling fan **30** cools the components, the cooling period is shorten based on the time that the door is open. When door **16** is open, cooking compartment **14** is directly cooled by outside air efficiently. As a result, any previously set cooling time would be longer than necessary enough.

Therefore since, in the present invention, the cooling period is changed when door **16** is open, cooling fan **13** can cool the components for a proper period.

Since temperature sensor **36** detects the temperature within cooking compartment **14**, the temperature sensor can be used both for determining the cooling period and maintaining a predetermined temperature during oven cooking.

Although only one embodiment has been described in detail above, those skilled in the art will readily understand that many modifications are possible in the preferred embodiment without departing from its teachings.

For example, although the embodiment describes a linear relationship between the temperature and the cooling period, of course the relationship could be on multiple steps. When an additional timer is used separately from microcomputer **28**, the counting speed may be altered by changing the frequency ratio of this timer's frequency divider.

When door **16** is open, the counting speed may be altered to something other than double the normal speed. Temperature sensor **36** may detect the temperature within components compartment **20** or rear portion **46**.

All such modifications are intended to be encompassed within the following claims.

What is claimed is:

1. A cooking appliance, comprising;

a) a cooking compartment for receiving food;

b) a door, which is coupled to the cooking compartment, for accessing the cooking compartment;

c) means, coupled to the cooking compartment, for heating food received in the cooking compartment;

d) a cooling fan for cooling the cooking compartment;

e) means for determining how long the door is open; and

f) means, responsive to the determining means, for changing period for operating the cooling fan in relation to how long the determining means determines that the door is open.

2. A cooking appliance comprising:

a) a cooking compartment for receiving food;

b) a door, coupled to the cooking compartment, for accessing the cooking compartment;

c) means, coupled to the cooking compartment, for heating food received in the cooking compartment;

d) a cooling fan, coupled to the cooking compartment, for cooling the cooking compartment;

e) means, coupled to the cooking compartment, for determining if the door is open; and

f) means for reducing a period for operating the cooling fan as the door is open for a longer amount of time.

3. A cooking appliance comprising:

a) a cooking compartment for receiving food;.

b) a door, coupled to the cooking compartment, for accessing the cooking compartment;

c) means, coupled to the cooking compartment, for heating food received in the cooking compartment;

d) a cooling fan, coupled to the cooking compartment, for cooling the cooking compartment;

e) means, coupled to the cooking compartment, for determining if the door is open;

f) means for detecting a temperature within the cooking compartment and for determining an initial period for operating the cooling fan based on the temperature; and

g) means for changing the initial period for operating the cooling fan based on the determination made by the determining means.

4. A cooking appliance according to claim 3, wherein the initial period determining means increases the initial period as the temperature becomes higher, and the changing means reduces the period for operating the cooling fan as the amount of time the door is open becomes longer.

5. A cooking appliance, comprising:

a) an outer case;

b) a cooking compartment in the outer case for receiving food;

c) a door, coupled to the outer case, for accessing the cooking compartment;

d) at least one component between the outer case and the cooking compartment;

e) means, coupled to the outer case, for cooling the at least one component;

f) temperature detecting means, coupled to the outer case, for detecting the temperature within the outer case;

g) means, coupled to the temperature determining means and the cooling means, for determining a period for operating the cooling means based on the temperature;

h) means, coupled to the period determining means, for counting the period;

i) open door determining means, coupled to the outer case, for determining if the door is open; and

j) means, coupled to the period counting means and the open door determining means, for changing a counting speed of the counting means in accordance with the determination made by the open door determining means.

6. A cooking appliance according to claim 5, wherein changing means increases the counting speed of the counting means while the door is open.

7. A cooking appliance, comprising:

a) an outer case;

b) a cooking compartment, located in the outer case, for receiving food;

c) a door, coupled to the outer case, for accessing the cooking compartment;

d) at least one component between the outer case and the cooking compartment;

e) cooling means, coupled to the cooking compartment, for cooling the component after cooking is finished;

f) temperature detecting means, coupled to the cooking compartments, for detecting the temperature within the cooking compartment;

g) period determining means, coupled to the cooling means and the temperature detecting means, for determining a period for operating the cooling means based on the temperature detected by the temperature detecting means;

h) counting means, coupled to the period determining means, for counting the period;

i) open door detecting means, coupled to the outer case, for detecting if the door is open; and

j) means, coupled to the counting means and the open door detecting means, for increasing a counting speed of the counting means while the door is open.

8. A cooking appliance according to claim 7, wherein the increasing means doubles the counting speed of the counting means while the door is open.

9. A method of controlling a cooling fan in a cooking appliance having a cooking compartment, comprising the steps of:

detecting the temperature within the cooking compartment;

determining a period of time for operating the cooling fan based on the detected temperature;

determining how long a door of the cooking compartment is open; and

changing the determined period of time in accordance with the determination of how long the door is open.

* * * * *